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Optimising torsion weeders and finger weeders

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This paper presents experiences from experiments in sugarbeets and leek. The effects of steering accuracy, implement adjustments and weed recovery are discussed. We suggest an experimental approach and assessment scheme that could improve our ability to account for several factors that influence the result of mechanical weeding.

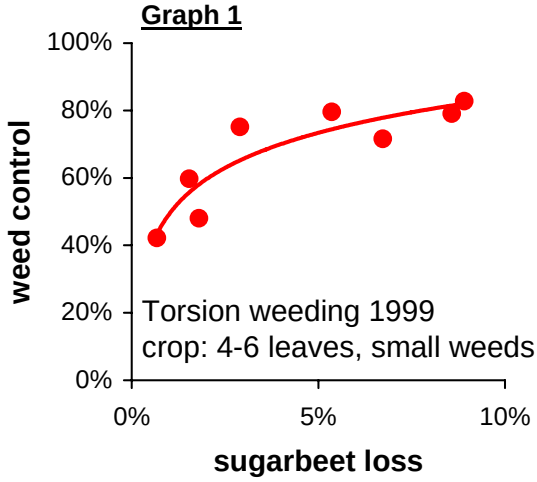
Table 1

	plant loss at 6-leaf stage		
soil disturbance	sugarbeet	small weeds	big weeds
0	1.4%	47%	6%
1	1.1%	56%	33%
2	5.8%	75%	18%
3	5.6%	76%	33%
significance	p<0.001	p<0.001	p=0.057

Torsion weeders in sugarbeets

When torsion weeding at the 6-leaf stage of sugarbeet on sandy soil, each pair of torsion weeders was adjusted identically. Nevertheless, weed control and sugar beet loss two weeks after treatment varied considerably between sites and between rows, due to differences in the soil disturbance intensity. Intense soil disturbance was associated with higher weed control and higher beet loss (table 1) and weed control and sugarbeet loss were closely related (graph 1). To attain the optimum combination of weed control and crop loss, the torsion weeders should be quicky and accurately adjustable and have improved depth control.

Graph 1



Torsion weeding at the 8-10-leaf stage uprooted 86% of the small weeds and 34% of the large weeds, whit only 5% crop loss. The lost beets were relatively small and it was observed that torsion weeders could flex around the sugarbeets. So, the whole intra-row zone could be loosened intensely to a depth of 2.5 cm. After two weeks, only 0 to 17% weed control was achieved. Apparently most of the uprooted weeds recovered, despite the four dry but clouded days after treatment.

In laboratory weeding experiments, mortality of uprooted seedlings strongly depended on the soil moisture content at harrowing, whereas covering hardly killed any plants. When ridging sugarbeets before canopy closure, the 3-5 soil cover was equally effective at dry circumstances or at 11 mm artificial precipitation applied directly after ridging. Therefore, combining assessments directly after weeding and before the next weeding provides insight in the potential and the weather-dependent actual effect, especially when uprooted, covered and undamaged plants are discerned.

Torsion weeders and finger weeders in transplanted leek

Three weeks after transplanting, leek plants were firmly anchored in the sandy soil, due to heavy rainfall. Even aggressive weeding with torsion weeders and finger

weeders (adjustments see table 2) did not cause any crop damage. When torsion weeders were adjusted backwards with tine-points pointing downwards (see photo), they were able to flex around the leek plants and uproot nearly all intra-row weeds. The more aggressive action of the torsion weeders improved weed control (assessed after one week).

Table 2

	working depth (cm)	overlap (cm)	speed km/h	weed control
Torsion weeders smooth	2.4	1.5	5	59%
Torsion weeders aggressive	2.7	5	8	81%
Torsion smooth + 2*finger	1.9	1.5/3.5	5/10	79%

In loose soil, finger weeders were not able to significantly move soil and weeds from the row, because of lacking slip of the rubber fingers. Nevertheless, finger weeding twice after torsion weeding improved weed control. Without torsion weeding, finger weeders could not penetrate the compact soil, which impedes weed control.

Experimental approach

Without accurate steering and implement adjustment, the weed control potential of intra-row weeders such as torsion weeders and finger weeders will be underestimated. Therefore, the most accurate implements available should be used. When several weeders are to be compared, mounting them side-by side on the same machine reduces the impact of steering errors, as all implements have the same error when operated simultaneously.

Furthermore, implements should be compared at a comparable level of crop damage, preferably the “optimum” combination of weed control and crop damage. As a comparable level is difficult to achieve and the optimum is not straightforward, we suggest using two levels of aggressiveness per implement. The “smooth” adjustment aims to achieve maximum control at a near-zero crop damage. The “aggressive” adjustment aims to achieve either 100% weed at minimum crop damage or maximum weed control at the maximum tolerated plant loss (e.g. 20%). The optimum adjustment is inbetween these extremes, but depends on the trade-off between cultivation costs, handweeding costs and yield loss.

Suggested assessments

In future experiments we try to account for factors that influence the weeding effect, by performing a set of assessments:

- Working depth and soil upheaval in the crop row, measured by 30 cm PVC sticks with a carve in the middle. Before cultivation, sticks are pushed into the soil with the carve level with the soil surface. After cultivation one can easily measure soil level upheaval and (after excavating the tilled soil) working depth.
- Immediate (at the day of cultivation) and final (before the next cultivation) weed control effect. When assessing the immediate effect, discerning types of damage (1: uprooted, both visible and covered; 2: covered but not uprooted; 3: not covered and not uprooted) provides valuable information in evaluating the effect of weather after cultivation.
- Defining a narrow intra-row counting zone, which has the same width before and after treatment is essential to discern the effect of hoeing (between rows) and the selective intra-row action. For example, the 40% weed control at 0% beet loss in graph 1 could be due to the narrowing of the counting zone. Instead of counting the number of weeds on a fixed counting plot area, we assessed the length of the intra-row strip that contains 50 plants. This method makes the accuracy of weed density assessments independent of the density itself. It is practical when weeding is very effective or when weed densities are low.

As these improvements are only suggestions and do not provide “the ultimate methodology”, we would like to discuss with other researchers to improve our field experiments. So, if you have thoughts on this matter, please contact us.